

Remarks

Status of application

Claims 1-43 were examined and stand rejected in view of prior art. The claims have been amended to address Examiner objections. Applicant's invention and the cited prior art are discussed in detail below, in an effort to further clarify Applicant's invention. Reexamination and reconsideration are respectfully requested.

General

Claims Objections

Claim 1 stands objected to, for insufficient antecedent basis for the term "the remote site" at line 10. The claim has been amended to provide antecedent basis for the term.

The invention

A database system providing improved methods for data replication is described and claimed. In one embodiment, for example, a method of the present invention is described for capturing database changes at a primary database and applying those changes to a replicate database located at a remote site while the replicate database remains on-line and available for use, the method comprises steps of: monitoring transactions occurring at the primary database for detecting changes made to the primary database; recording information about transactions observed to have occurred at the primary database in a transaction log; synchronously copying the information about the transactions recorded in the transaction log to the remote site, so as to create at the remote site a mirrored transaction log that is guaranteed to contain at a synchronized point in time an exact copy of the transactions recorded in the transaction log at the primary database; while the replicate database remains on-line and available for use, replicating changes made at the primary database to the replicate database by: reconstructing the transactions at the replicate database based on the information about the transactions copied to the mirrored transaction log; and asynchronously applying the reconstructed transactions at the replicate database.

Prior art rejections

A. Section 102(b): Kolovson

Claims 1-8, 10-23, 25-32, 34-43 stand rejected under 35 U.S.C. 102(b) as being anticipated by Kolovson (US 5,951,695), hereinafter "Kolovson". Kolovson describes a database system that facilitates quick failover (see, e.g., Kolovson Abstract). The database system includes a primary node, a standby node, and a fast interconnect between the primary node and the standby node. The primary node includes a primary buffer pool which stores pages of the database information, and a log storage which receives a log of updates for the pages within the primary buffer pool. When a page is to be updated by a primary node, the primary node sends a copy of a before update image of the page to the standby node. When the primary log writes logs of updates to the log storage, the primary node also forwards the logs of updates to the standby node. For the reasons stated below, Applicant's claimed invention may be distinguished on a variety of grounds.

Applicant's invention offer a synchronous replication solution with asynchronous application, yielding a low-latency, high performance solution that preserves fidelity yet conserves resources. In Applicant's last-filed Amendment, the claims were amended to emphasize Applicant's approach of synchronously replicating from the primary database to a remote site, and from there employing asynchronous replication against a "live" replicate database. This combination provides the benefits of logical replication, including for example protection against corruption at the primary and lower resource impact to the primary, while allowing the replicate database to remain online (i.e., "live") for processing new transactions (e.g., decision support reporting transactions or the like). At the highest level, Kolovson shares features in common with Applicant's database system: both are database systems with primary and secondary (e.g., standby) nodes. A more detailed review of Kolovson however reveals that his system diverges substantially from Applicant's system and does not provide core features that are the focus of Applicant's patent claims.

For purposes of database recovery, the more time it takes to do recovery (e.g.,

based on database checkpoints) the longer fail-over takes. The basic idea behind Kolovson's approach therefore is to increase the frequency of checkpoint time (and therefore decrease the amount of database log required to be read upon fail-over) without negatively affecting database performance. A threshold question immediately arises with Kolovson's approach: Is Kolovson's standby node even active or "live" (i.e., on-line and available for use)? A "live" standby is a fundamental feature of Applicant's invention, as described and claimed (see, e.g., claim 1, at line 12). A review of Kolovson indicates that the Kolovson's standby node is clearly not active at all. Instead, Kolovson's standby node remains inactive during normal operation; on fail-over Kolovson's standby node must be activated (i.e., brought online for live transactions). When Kolovson's standby node starts up (upon fail-over), Kolovson's particular innovation is to decrease fail-over time by decreasing the amount of the log that needs to be read. Kolovson's described approach fails to meet Applicant claim limitations that require the replicate database to remain on-line and available for use -- if anything, Kolovson's "start-up upon failure" approach teaches away from Applicant's claimed "live" approach.

The distinction is not trivial and has a significant impact on overall system performance. The focus of both Kolovson's and Applicant's solutions is to decrease the fail-over time, so that any standby or secondary node is available with the least amount of latency. Significantly, Applicant's secondary or replicate node remains active or live during system operation so that fail-over can occur instantly (i.e., little or no delay). In Kolovson's system, the standby node is not live and thus delay or latency is incurred in bringing the standby node up to active state.

There are other differences. For instance, Kolovson indicates that his primary and standby nodes share the same data, that is, there is only one real copy of the data itself (i.e., a single data store). That approach is problematic for fail-over however. During recovery from fail-over, for example, Kolovson indicates an initial step of activating connections to database disk and log files on the failed primary node (see Kolovson's step 121, Fig. 11). Clearly, Kolovson's approach assumes the database disk and log files are actually available on the failed primary node. Although that assumption may have worked back in 1997 when Kolovson's patent was filed, it clearly is not valid after September 11th, 2001. If a primary node fails, the database disk and log files may very

well not be available -- the entire physical computer may in fact no longer exist.

In Applicant's approach, a shared copy is not used. Instead, separate primary and replicate copies of the data exist, where the primary is replicated to a remote in a synchronous manner. Since Kolovson's operations depend on a single shared copy of the data, the Examiner's contention that Kolovson teaches Applicant's claim limitations pertaining to creating "at the remote site a mirrored transaction log that is guaranteed to contain at a synchronized point in time an exact copy of the transactions recorded in the transaction log at the primary database" cannot be understood. At best, Kolovson only copies bits and pieces (not the entire data store) for purposes of decreasing fail-over time. Kolovson does not maintain a separate standby data store that remains online and available at all times.

For the reasons stated, it is respectfully submitted that the claims distinguish over Kolovson. In particular, recent amendments to Applicant's claims emphasize Applicant's approach of synchronously replicating from the primary database to a remote site, and from there employing asynchronous replication against a "live" replicate database to provide a ready standby. Synchronous replication combined with logical asynchronous replication yields all of the benefits of logical replication, including for example protection against corruption at the primary and lower resource impact to the primary. At the same time, the approach allows the replicate database to remain online for processing new transactions (e.g., decision support reporting transactions or the like). Accordingly, it is believed that the claims are patentable under Section 102.

B. Section 103: Kolovson and Riedel

Claims 9, 24 and 33 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Kolovson as applied to claims 1-8, 10-23, 25-32, 34-43 above, and in view of Riedel et al. ("When Local Becomes Global: An Application Study of Data Consistency in a Network World"), hereinafter "Riedel". Here, the Examiner repeats the base rejection (predicated on Kolovson), but adds Riedel for the proposition that it teaches Applicant's claim limitations that the synchronously copying step includes replicating at a file block level.

The claims are believed to be allowable for at least the reasons stated above

pertaining to Kolovson. To the point, Kolovson does not teach or suggest Applicant's approach of synchronously replicating from the primary database to a remote site, and from there employing asynchronous replication against a replicate database to create a "live" standby -- a standby that remains on-line and available for processing transactions. The Examiner has cited nothing in Riedel that remedies that deficiency.

Any dependent claims not explicitly discussed are believed to be allowable by virtue of dependency from Applicant's independent claims, as discussed in detail above.

Conclusion

In view of the foregoing remarks and the amendment to the claims, it is believed that all claims are now in condition for allowance. Hence, it is respectfully requested that the application be passed to issue at an early date.

If for any reason the Examiner feels that a telephone conference would in any way expedite prosecution of the subject application, the Examiner is invited to telephone the undersigned at (408) 884 1507.

Respectfully submitted,

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